

THE HELSINKI OFFICE ENVIRONMENT STUDY: THE TYPE OF VENTILATION SYSTEM AND THE "SICK BUILDING SYNDROME"

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ABSTRACT

The objective of the present study was to assess the types of heating, ventilating and air conditioning (HVAC) systems in office buildings as determinants of the occurrence of symptoms of the "sick building syndrome" (SBS) and perceived air quality in workers. In the Helsinki Office Environment Study a self-administered questionnaire was directed at the occupants of 41 buildings selected randomly from all the 894 eligible buildings in the Helsinki metropolitan area. The study population included 2678 office workers who returned a filled in questionnaire (response rate 81%). The outcomes included the occurrence of nine weekly work-related symptoms of the SBS and perceptions of thermal comfort and unpleasant odors during the past 12 months. The symptoms were slightly more common among the occupants of the buildings with simple mechanical ventilation than among the occupants of the naturally ventilated buildings. The risk of nasal symptoms, and central nervous symptoms such as lethargy and difficulties in concentrating, was significantly greater in workers in buildings with evaporative but not with steam humidification, compared to workers in both naturally and mechanically ventilated buildings without humidification. The risk of nasal congestion was significantly increased in the workers of buildings with air recirculation compared to similar buildings without air recirculation.

INTRODUCTION

During the past decade reports from both Europe and North America have indicated that non-specific symptoms and perceptions of poor indoor air quality are common in office workers and there is considerable variation between different buildings in the occurrence of symptoms. The similar pattern in the symptoms has given rise to the concept of the "sick building syndrome" (SBS)(1). The symptoms and perceptions have often been attributed to the characteristics of the HVAC system and several studies have compared the occurrence of the symptoms in buildings fitted with different types of ventilation systems (1-5). The results have been inconsistent.

We carried out a population-based cross-sectional study in order to assess the HVAC systems in office buildings as determinants of the occurrence of symptoms of the SBS and perceived air quality in workers. The types of ventilation systems considered were natural ventilation, mechanical exhaust of air, simple mechanical ventilation, air-conditioning without and with steam or evaporative humidification and recirculation of the air.

Table 1. Age and sex standardized prevalences (%) of weekly, work-related symptoms and perceptions during the previous 12 months in office buildings with different ventilation systems.

Symptom/Perception	Natural (I) N=250	Mechanical exhaust (IB) N=206	Simple Mechanical (II) N=1210	Air- Conditioned No Humidific. (III) N=618	Air- Conditioned Steam Humidific. (IV) N=85	Air- Conditioned Evaporative Humidific. (V) N=309	Total N=2678
Eye symptoms	6.4	6.1	9.5	10.5	9.3	9.5	9.1
Nasal irritation	10.5	7.4	12.2	14.2	11.9	17.0	12.5
Nasal congestion	4.6	6.9	8.5	9.2	7.7	12.9	8.5
Nasal discharge	3.9	2.5	5.7	6.4	5.9	11.4	6.1
Pharyngeal symptoms	2.6	4.0	5.7	6.2	4.6	6.2	5.3
Skin symptoms	4.7	5.4	5.7	5.7	4.6	7.6	5.6
Headache	4.5	3.5	4.7	6.0	1.8	7.4	5.2
Lethargy	6.6	11.1	11.6	12.1	7.2	16.2	11.5
Difficulties in concentrating	5.3	4.3	5.5	8.3	9.6	7.3	6.2
Too warm	16.0	29.9	22.5	22.5	16.9	35.8	23.6
Too cold	19.2	24.8	15.2	21.3	30.3	20.1	18.5
Too dry	28.7	29.1	36.2	37.1	31.1	38.7	35.1
Unpleasant odor	25.6	22.2	19.4	20.9	15.2	25.3	21.1

Table 2. Adjusted odds ratios (OR) for weekly, work-related symptoms and perceptions during the previous 12 months in office buildings with different ventilation systems.

Symptom/Perception	Mechanical Exhaust (IB)		Simple Mechanical Ventilation (II)		Air-Conditioned No Humidification (III)		Air-Conditioned Steam Humidification (IV)		Air-Conditioned Evaporative Humidification (V)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95%
Eye symptoms	0.73	0.34-1.55	1.24	0.72-2.11	1.34	0.76-2.37	1.32	0.53-3.27	1.08	0.56-2.09
Nasal irritation	0.86	0.46-1.64	1.14	0.71-1.81	1.32	0.81-2.18	1.53	0.70-3.37	1.60	0.93-2.77
Nasal congestion	1.76	0.80-3.88	1.83	0.97-3.48	1.93	0.98-3.80	1.96	0.68-5.61	2.79	1.36-5.73
Nasal discharge	0.87	0.33-2.26	1.51	0.76-2.98	1.47	0.71-3.04	1.57	0.47-5.29	2.41	1.12-5.16
Pharyngeal symptoms	1.50	0.54-4.18	2.07	0.92-4.68	1.98	0.84-4.69	3.10	0.92-10.45	1.86	0.73-4.77
Skin symptoms	0.87	0.33-2.26	1.01	0.55-1.88	0.91	0.46-1.80	1.37	0.46-4.10	1.17	0.55-2.48
Headache	0.45	0.17-1.15	0.78	0.42-1.44	1.02	0.53-1.98	0.45	0.10-2.11	1.13	0.54-2.39
Lethargy	1.53	0.79-2.99	1.67	0.98-2.86	1.67	0.94-2.94	0.58	0.16-2.09	2.37	1.28-4.36
Difficulties in concentration	0.67	0.24-1.82	1.23	0.61-2.49	1.79	0.87-3.70	1.40	0.45-4.41	1.77	0.80-3.95
Too warm	2.19	1.36-3.51	1.65	1.12-2.42	1.50	1.00-2.27	1.22	0.62-2.40	2.59	1.67-4.01
Too cold	1.43	0.90-2.27	0.74	0.51-1.07	1.12	0.76-1.66	1.39	0.75-2.57	0.90	0.57-1.41
Too dry	1.00	0.65-1.53	1.44	1.05-1.98	1.46	1.04-2.05	1.35	0.78-2.35	1.48	1.01-2.18
Unpleasant odor	0.85	0.54-1.34	0.69	0.49-0.97	0.76	0.53-1.10	0.55	0.28-1.08	0.85	0.56-1.29

Adjustment was made in the logistic regression for gender, age, atopy, education, personal smoking, number of workers in the office, passive smoking, textile wall material, sealed windows, work with video display unit, handling of self-copying paper, photocopying, and psychosocial index.

DISCUSSION

We carried out a population-based cross-sectional study to assess the role of different types of air handling in the Finnish office buildings as determinants of the SBS symptoms and perceived air quality among the workers. The sampling frame made it possible to make an unbiased estimate of the occurrence of symptoms and perceptions of poor air quality and to assess the type and performance of the ventilation systems in the Helsinki metropolitan office building stock. Due to the similarity of the people, architecture and construction technology, the results are reasonably well generalizable to the office buildings in the rest of the country. Unlike in many similar studies, we were able to adjust for a number of personal, behavioral and psychosocial factors, type of work environment and work habits.

Finnish workers in office buildings with mechanical supply and exhaust of air seem to have a slightly higher risk of typical work-related symptoms of the SBS than workers in naturally ventilated buildings. This observation is consistent with the results of the studies from England (1,3) and the Netherlands (6). Also the use of air recirculation is related to a slightly increased risk of nasal symptoms in the Finnish building stock. In our previous four-period cross-over trial we were able to show that 70% recirculation of air can be used without causing adverse effects when accompanied by an adequate intake of outdoor air (7). Evaporative humidification is a determinant of both nasal, pharyngeal and central nervous symptoms in Finnish office buildings. Steam humidification does not seem to be related with the SBS symptoms among workers in mechanically ventilated buildings. In our cross-over trial, 20-30% steam humidification decreased the amount of dryness and allergic symptoms during a cold winter period when relative humidity without humidification was low (<20%) (8).

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